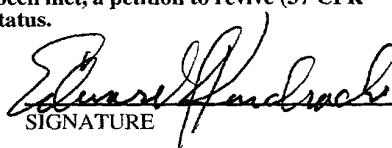


FORM PTO-1390 (Modified) (REV 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER <b>T2146-907404</b>
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. 7 CFR <b>09/889416</b>		
INTERNATIONAL APPLICATION NO. <b>PCT/FR00/03193</b>	INTERNATIONAL FILING DATE <b>17 November 2000</b>	PRIORITY DATE CLAIMED <b>17 November 1999</b>		
TITLE OF INVENTION <b>Method for Loading Applications in a Multiapplication Onplatform System Equipped with Data Processing Resources, Corresponding Executing System and Method</b>				
APPLICANT(S) FOR DO/EO/US <b>Christian GOIRE and Jean Paul BILLON</b>				
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:				
<ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.</li> <li><input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).</li> <li><input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2))             <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li>b. <input checked="" type="checkbox"/> has been communicated by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li><input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).             <ol style="list-style-type: none"> <li>a. <input checked="" type="checkbox"/> is attached hereto.</li> <li>b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</li> </ol> </li> <li><input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))             <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li>b. <input type="checkbox"/> have been communicated by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li><input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).</li> <li><input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).</li> <li><input type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409).</li> <li><input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210).</li> </ol>				
<b>Items 13 to 20 below concern document(s) or information included:</b> <ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li><input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li><input type="checkbox"/> A <b>FIRST</b> preliminary amendment.</li> <li><input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li><input type="checkbox"/> A substitute specification.</li> <li><input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li><input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.</li> <li><input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).</li> <li><input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).</li> <li><input type="checkbox"/> Certificate of Mailing by Express Mail</li> <li><input checked="" type="checkbox"/> Other items or information:</li> </ol>				
<b>PCT - Notification de la Reception de L'exemplaire Original</b> <b>PCT - Notification Relative A La Presentation Ou A La Transmission Du Document De Priorite</b> <b>PCT - Avis Informant Le Deposant De La Communication De La Demande Internationale Aux Offices Designes</b> <b>PCT - Requete</b>				

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>09/889416</b>	INTERNATIONAL APPLICATION NO. PCT/FR00/03193	ATTORNEY'S DOCKET NUMBER <b>T2146-907404</b>																
24. The following fees are submitted:		<b>CALCULATIONS PTO USE ONLY</b>																
<b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b>																		
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1000.00</b> <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b> <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b> <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b> <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b>																		
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<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">CLAIMS</th> <th style="width: 25%;">NUMBER FILED</th> <th style="width: 25%;">NUMBER EXTRA</th> <th style="width: 25%;">RATE</th> </tr> </thead> <tbody> <tr> <td>Total claims</td> <td>15 - 20 =</td> <td>0</td> <td>x \$18.00    <b>\$0.00</b></td> </tr> <tr> <td>Independent claims</td> <td>3 - 3 =</td> <td>0</td> <td>x \$80.00    <b>\$0.00</b></td> </tr> <tr> <td colspan="2">Multiple Dependent Claims (check if applicable).</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><b>\$0.00</b></td> </tr> </tbody> </table>		CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	Total claims	15 - 20 =	0	x \$18.00 <b>\$0.00</b>	Independent claims	3 - 3 =	0	x \$80.00 <b>\$0.00</b>	Multiple Dependent Claims (check if applicable).		<input type="checkbox"/>	<b>\$0.00</b>	
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<input type="checkbox"/> Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.		<b>\$0.00</b>																
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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).		<input checked="" type="checkbox"/> <b>\$40.00</b>																
<b>TOTAL FEES ENCLOSED =</b>		<b>\$900.00</b>																
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a. <input checked="" type="checkbox"/> A check in the amount of <b>\$900.00</b> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <b>501165</b> . A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. <b>WARNING:</b> Information on this form may become public. <b>Credit card information should not be included on this form.</b> Provide credit card information and authorization on PTO-2038.																		
<b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>																		
<b>SEND ALL CORRESPONDENCE TO:</b> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">           Edward J. Kondracki, Esq.            MILES &amp; STOCKBRIDGE P.C.            1751 Pinnacle Drive            Suite 500            McLean VA 22102-3833            Telephone: (703) 610-8627         </div> <div style="text-align: right;">   <b>SIGNATURE</b>  <hr/> <b>Edward J. Kondracki</b>  <hr/> <b>NAME</b>  <hr/> <b>20,604</b>  <hr/> <b>REGISTRATION NUMBER</b>  <hr/> <b>July 17, 2001</b>  <hr/> <b>DATE</b> </div>																		

4/PRTS

**METHOD FOR LOADING APPLICATIONS IN A MULTIAPPLICATION  
ONPLATFORM SYSTEM EQUIPPED WITH DATA PROCESSING RESOURCES,  
CORRESPONDING EXECUTING SYSTEM AND METHOD**

5 The present invention concerns a method for loading applications into a multi-application embedded system equipped with data processing resources, the corresponding embedded system, and the method for executing an application of a corresponding embedded system.

10 The present invention more specifically concerns the creation of a firewall between modules sharing the same memory space in systems embedded in multi-application portable objects using an intermediate pseudocode and an associated virtual machine.

15 The "Java" (registered trademark) technology introduced by Sun is based on an object-oriented programming language, "Java," and an associated virtual machine. This technology was developed on stations or PCs, hereinafter referred to as conventional Java platforms, having high CPU power and a large memory on the order of 1 megabyte.

20 For several years, the concepts of Java technology have been adopted and adapted to run on embedded systems in portable objects, for example in the format of a credit card or a SIM micromodule incorporating a microprocessor and commonly called a smart card, GSM (Global System for Mobile Communication) portable telephones, PCMCIA cards or any other portable terminals. Hereinafter, the term card will be used to designate any of these portable objects. The programming of embedded systems, heretofore performed in an assembly language, is now possible in an advanced language like Java, making it possible to accelerate the development of client applications.

25 This new type of platform specific to the embedded systems of a portable object, hereinafter called a specific platform, constitutes a subsystem of the conventional platform. The differences result from the smaller environment of embedded systems. Conventionally, as represented in Fig. 4a, a smart card (10) comprises an input-output system (11) linked to the microprocessor (14), a volatile RAM (Random Access Memory) (12), a nonvolatile memory constituted by a ROM (Read-Only Memory) and a programmable nonvolatile 30 memory (15) constituted by a flash RAM or EEPROM (Electrically Erasable Programmable Read-Only Memory). All of these elements are linked to the microprocessor by a link bus.

For example, in the best of cases using the newest currently existing components, a smart card comprises a ROM a 32-kilobyte EEPROM, and a 2-kilobyte RAM.

In a conventional Java system, an application is written on a station or PC. Its source code is complied into an intermediate pseudocode called “Java Byte Code” or byte code, which is independent of the machine code of the platform used. The application is then downloaded into the target platform or conventional Java platform. The loaded application, constituted by a set of classes called client classes, whose methods have been compiled into the pseudocode, is based on application program interfaces or APIs. Application program interfaces make it possible to standardize the user interface, to control an editor, a keyboard or a printer, for example. The virtual machine of a conventional platform comprises a pseudocode verifier, a dynamic class loader, a pseudocode interpreter for translation into machine code, and a security manager.

The main difference between a conventional virtual machine and a virtual machine of an embedded system, called a specific virtual machine, is due to the fact that the virtual machine of an embedded system is broken down into two separate parts. According to Fig. 4b, the virtual machine comprises a part (30) outside the specific platform (40), called an “off-platform” virtual machine, comprising a converter (32) and a part (41) inside the card constituting the specific platform (40), called an “on-platform” virtual machine, which includes the pseudocode interpreter.

Thus, in the case of a specific platform, the source program (21) of the application is written, compiled into intermediate pseudocode by a compiler (22), and verified by an intermediate pseudocode verifier (31) in a conventional station (20), then converted by the converter (32), located in the same station (20) or in another station. After possibly passing through a signer (34), the application is then downloaded into the EEPROM (15) of the portable object or specific platform (40). This loading is performed by a loader comprising an off-platform part called a downloader (33), and an on-platform part called a loader (42). Unlike what exists in a conventional platform for a station, the virtual machine (41) of a specific platform (40), located in ROM with the operating system (48), cannot include an intermediate pseudocode verifier, which is too large to be stored and/or run in the portable object. Nor does the specific platform (40) contain a dynamic class loader. In fact, for the field of application of the invention, in the off-platform virtual machine (30), the verifier (31) verifies that the compiled classes are correctly formed, and verifies the language violations

specific to the description of the specific platform. The converter (32) does the work required to load the classes and resolve the references. The converter handles the static linking of the classes, and resolves the symbolic references to the classes, methods and attributes already present in the card. It apportions storage and creates the data structures for representing the  
5 classes, creates the static or native methods and attributes, and initializes the static variables.

The runtime environment (or RE) of the specific platform comprises the “on-platform” virtual machine (41), limited to an interpreter, an API platform, and the associated so-called native or static methods (43). The API platform comprises the APIs (Application Program Interfaces) (44) defining a set of classes called system classes (45), and the call  
10 conventions by means of which an application accesses the runtime environment (RE) and the static methods (43). The static methods (43) execute the memory allocation, input and output, and cryptographic services of the card.

The interpreter of the “on-platform” virtual machine of the card (41) supports the Java language, and reads the intermediate pseudocode sequentially, instruction by instruction. Each conventional instruction of this intermediate pseudocode is interpreted in the language of the microprocessor by the interpreter, then executed by the microprocessor. As a general rule, the conventional instructions of the intermediate pseudocode make it possible to handle advanced functions such as arithmetic processing and object manipulation. The notion of an object relates to data processing objects such as lists, data arrays or the like. The so-called client classes (46) of the applications and the system classes (45) of the APIs are all loaded into the same memory space and are managed by means of a class table (47).

The virtual machine (41) is also responsible for managing the classes and objects and for maintaining the separations or firewalls between the applications so as to allow secure sharing of the data, also called attributes, variables or fields.  
25

In the case of a portable object like a smart card, an application of a specific platform can be activated directly by the runtime environment (RE) when a selection APDU (Application Protocol Data Unit) sent by a service or terminal is received by the card.

In order to restrict access to the data among the code parts sharing the same memory space, one of the conventional methods in a conventional platform is based on an explicit  
30 restriction of visibility declared in the source code. According to Fig. 4c, the methods (NM1, NM2) and (NM3, NM4), respectively, and the attributes (NA1, NA2) and (NA3, NA4), respectively, are encapsulated into classes (NCI3) and (NCI2), respectively, which

themselves belong to packages (Package 1) and (Package n), respectively, each of which contains several classes. A class can be public, like (NCI1 or NCI2), or private, like (NCI3), in relation to a package, which in the latter case implies that only the classes of the same package can access this class. The methods (for example NM2) and the data (for example NA1) of one class (NCI3) can be private in relation to the class (NM1, NA1), which is itself private in relation to the package (Package 1), or public in relation to the package (for example NM1, NA2). This restriction of visibility makes it possible to obtain flexible access among the various sets of packages (Package 1, Package n) stored in the same name space, but it has several disadvantages. The conventional or specific platform does not support the notion of sub-packaging well. The client classes of an application of large size must be distributed among various sub-packages, which represent different packages only for the virtual machine. In order for these resources to be shared among these sub-packages, these resources are necessarily declared public, thus rendering them visible to any other package. It is thus difficult to clearly organize the packaging of various applications for applications of large size, and to obtain firewalls between the applications.

In the case of the conventional platform, in a station, the maintenance of the confidentiality of the resources as declared in the source programs is based on dynamic verifications. In order to perform these dynamic verifications, the virtual machine must have all the information relative to the declarations of the access restrictions for each class, method or attribute, which is impossible in the case of the memory space available in the on-platform virtual machine using the pre-linked intermediate pseudocode or byte code of the off-platform virtual machine. In the case of a specific platform of a portable object, the access restrictions can be verified statically during the compilation and can be re-verified by the verifier of the off-platform part. It is essentially assumed that what is loaded into the specific platform of the portable object is correct, since no verification can be performed in the specific platform due to the loss of information during the conversion phase. Moreover, there is no guarantee that a package cannot be extended or modified by new classes coming from alien sources, which can entirely destroy any security based on the utilization of private packages.

The second means provided by the virtual machine of a conventional platform is the notion of name space separation. With the dynamic linking schema of a conventional platform, the classes can be loaded from directories of the local file system called

“ClassPath,” previously declared as constituting the location of the system classes forming the conventional API platform, or from other directories of the local file system or from remote servers. The client classes of an application, outside the “ClassPath,” must be loaded by a specifically programmed class loader. This characteristic is used particularly for loading

5 Java applications via authorized Java browsers. Thus, applications coming from different sources are loaded by different class loaders. For each locator, commonly called a URL (Uniform Resource Locator), a specific instance of a class “application class loader” is used. The external name of a class is the assembly <Name Of Package> + <Name of Class>. When a class is loaded, it is stored in an internal class table, and a reference related to the class

10 loader used to load this class is added into a prefix of the name of the package of the class. The name of the class is therefore <<Reference of Class Loader> + <Name of Package> + <Name Of Class>>. Thus, classes declared as belonging to the same package but loaded by different class loaders are not perceived by the virtual machine as belonging to the same package.

15 During the resolution of a reference, the usual policy of class loaders is to first search in the system classes, and in case of failure, to search through the class files present at the location where the loader can load the classes. According to this operating principle of the loader, an application cannot directly access the client classes of another application loaded by a different class loader. An application can access all the public resources of the public classes of the ClassPath, but the classes of the ClassPath cannot directly access the classes of an application, although they can refer to instances of client classes of the application by converting them into a public type defined in the ClassPath. An application cannot extend or modify packages of system classes of the ClassPath or of any other applications loaded by different class loaders. Using name space separation by inserting a reference of the class

20 loader into the name of the class, in addition to the complete typing provided by the Java language, makes it possible to provide an effective firewall between the applications. The innate name space separation mechanism makes it easy to load new applications. The applications can exchange objects by interjecting classes specifically programmed for this purpose and located in the “ClassPath.” An application can use an object coming from

25 another application loaded by a different class loader if this object can be changed into a public type defined in the “ClassPath.”

Unfortunately, this name separation mechanism, based on a conventional virtual machine and its dynamic linking process, cannot be implemented in a specific platform. The dynamic linking cannot be performed by the virtual machine of a specific platform, since it requires a memory space that allows the storage of a class file of a conventional Java 5 platform having unresolved references. In a specific platform, the system classes of the APIs and the client classes of the applications are not isolated in particular naming spaces.

The object of the present invention is to offer a solution that provides the advantages of name separation in the context of embedded systems having a two-part virtual machine, the static linking schema being implemented by the off-platform part.

10 In the context of multi-application embedded systems, such as for example payment terminals, it is necessary to have high-performance firewalls between Java applications furnished by different sources, such as different payment systems (Visa, MasterCard, etc.). It can be useful to allow flexible cooperation between applications coming from different sources. The embedded system should also be easy to update by downloading new 5 applications or new utility modules, or upgrades, without disturbing the applications already loaded.

A first object of the invention is to offer a loading method that makes it possible to obtain robust firewalls between the applications, while allowing cooperation between the applications and making it possible to upgrade the applications or to load other applications.

0 This object is achieved through the fact that the method for loading applications into an embedded system according to the invention, comprising a runtime environment including a virtual machine comprising an intermediate pseudocode language interpreter and application programming interfaces (API), from a station on which the source code of the application is written, compiled into pseudocode by a compiler, verified by a verifier, 25 converted by a converter and loaded by a loader, is characterized in that:

- the conversion comprises the performance of the static linking of a plurality of sets of packages to be stored in the same name space in the embedded system, called modules, by assigning an identifier to each module (MID), and a reference number to each class, each method and each attribute encapsulated in the classes of the module,

30 - the reference to a method or an attribute in the linked pseudocode of a module,, being coded in three bytes constituted by an indicator indicating the reference to a class

internal or external to the module, the number of the class, and either the number of the method or the number of the attribute,

- the modules loaded are one or more application program interface modules, called API modules, comprising system classes or service modules, each corresponding to an application, a reference to an external class being systematically interpreted by the virtual machine as a reference to an application program interface module.

According to another characteristic, the loading of the modules into the embedded system comprises the storage of at least one array representing the modules, the number between 0 and n associated by the linker with a module constituting the index of said module in the array, and a table storing the association of the index in the array representing the identifier (MID) of said module, said array and the table being in programmable nonvolatile memory, an external reference to an external module in the pseudocode being interpreted by the interpreter of the virtual machine as constituting an index for access to the module equivalent to the one in the module array.

According to another characteristic, the loading comprises the storage, for each module, of an array representing its classes, comprising a reference to the index of its module and, for each class, an array representing attributes and methods.

According to another characteristic, the modules are referenced in a single module array, the system classes are contained in a single API module, and any reference to an external class in the pseudocode different from n will be interpreted by the virtual machine as a reference to said API module.

According to another characteristic, the classes being declared public, or in private packages, the attributes and methods being declared protected, in private packages or in private classes, the numbering of the classes is done in order of the public classes followed by the classes in private packages; the numbering of the attributes or methods is done by the converter in order of the attributes or methods that are public, protected, in private packages, and in private classes.

According to another characteristic, the system classes are contained in several API modules that can be loaded separately, the loader maintains in the programmable nonvolatile memory two arrays representing modules and two corresponding MID/IMI association tables, one for the API modules and the other for the non-API modules, the loader loading the modules into one of the two arrays based on the nature of the module specified in its header,

any external reference of a module of the module array being interpreted as a reference to the index of the API module.

According to another characteristic, the static linking of a module is performed in such a way that the reference to a class external to a non-API module in the intermediate pseudocode is an index in an array of the header of the module, wherein each entry is an identifier (MID) of a referenced API module, the loading of said module into the target platform comprising the replacement of said reference with the number of the index of the API module obtained from the identifier (MID) in the MID/IMi association table of the API modules.

10 Another object of the invention is to offer a corresponding embedded system.

This object is achieved through the fact that the embedded system according to the invention, comprising a virtual machine and an API platform including application program interfaces, a fixed nonvolatile memory, a programmable or modifiable nonvolatile memory, and a random access memory, is characterized in that the programmable nonvolatile memory comprises at least one API module comprising system classes and service modules, at least one array representing modules, in which the modules are indexed, and a table associating the index of a module in the representing array with the identifier of said module, each module comprising an array representing classes, in which the classes are indexed and in which each class has a reference to the index of its module, each class comprising an array representing attributes and methods, in which the attributes and methods are indexed, the reference to a method or an attribute being coded in at least three bytes corresponding to a reference to a class internal or external to the module, a reference external to the module constituting the index of the API module in the module array, a class number corresponding to the index of the class in the table representing the classes of the module, and a method or attribute number corresponding to the index or the method or the attribute in the array representing the methods or attributes of the class of the module.

According to another characteristic, the embedded system includes means for comparing the first byte of the three bytes encoding a reference to a method or an attribute to a given value n in order to decide whether it is an internal or an external class.

30 According to another characteristic, the embedded system comprises a main module comprising the main program of the system.

According to another characteristic, the classes are indexed in order of the public classes, followed by the classes in private packages, and the attributes and methods are indexed in order of the attributes or methods that are public, protected, in private packages, and in private classes.

5 According to another characteristic, the programmable nonvolatile memory comprises several API modules comprising system classes, two arrays representing modules, one for the API modules and the other for the non-API modules and the main module, and two MID/IMi association tables, each corresponding to an array representing modules.

10 According to another characteristic, the embedded system comprises an access manager class “Access Manager” of an API module comprising a method that makes it possible to create an instance of a service module, via the main module, said class having a protection that prohibits it from having more than one instance.

Another object of the invention is to offer a method for executing an application present in a multi-application embedded system.

15 This object is achieved through the fact that the method for executing an application of a multi-application embedded system, comprising a runtime environment including a virtual machine comprising an intermediate pseudocode language interpreter and application programming interfaces (API), is characterized in that during the execution of the intermediate pseudocode of a service module, corresponding to an application, referenced in a module array, the reference to a method or an attribute in the pseudocode, coded in at least three bytes corresponding to a reference to a class internal or external to the module, a class number and a method or attribute number, a reference external to the module is interpreted by the virtual machine as a reference to the index of an API module in the array of the API module or modules.

20 25 According to another characteristic, upon reception of a request for execution of a service module having an identifier, the runtime environment accesses the input class of a main module comprising the main program of the system, the main module installs an instance of a special class “Access Manager” of an API module that controls access to a service module and uses a method of this class for creating an instance of the input class of the requested service module, by means of a table associating the identifier with the index of the module in an array in which the module is referenced, the instance being returned by the method to the main program.

Other characteristics and advantages of the present invention will emerge more clearly with the reading of the description below, written in reference to the attached drawings in which:

- Fig. 1 schematically represents the various elements required for loading a portable object according to a first embodiment;
- Fig. 2 schematically represents the various elements required for loading a portable object according to a second embodiment;
- Fig. 3 represents the internal representation of a module;
- Fig. 4a represents the conventional diagram of a smart card;
- Fig. 4b represents the system required to constitute a virtual machine embedded in a smart card according to the prior art.
- Fig. 4c represents the structure of the classes of an application.

The method will be described in connection with Figs. 1 through 3, in a non-limiting way, in the case of the implementation of the invention in an embedded system, for example of the specific type constituted by a smart card or a similar portable object. The designation byte code or byte code program covers any intermediate pseudocode or program.

The portable object constitutes, for example, a smart card and has a structure similar to the one described above in reference to Figs. 4a and 4b, and specifically comprises a RAM, ROM and EEPROM. The specific platform (60) and a conventional station (80) have, in ROM, a runtime environment (RE) comprising APIs (62) and an “on-platform” virtual machine (61). The specific platform (60) is represented in Fig. 1 as comprising the set of memories ROM and EEPROM. It should be noted that the specific platform (60) more specifically designates the runtime environment (RE) and the elements present in EEPROM. The portable object has, in ROM, an operating system (63). The APIs (62) present in ROM constitute the basic APIs of the API platform, loaded with the on-platform virtual machine for running the latter.

The part (90) of the virtual machine outside the portable object comprises an intermediate pseudocode verifier (91), a converter (92) and possibly a signer (94). The signer delivers a signature for validating the passage through the verifier and the converter. This signature will be verified by the portable object at the time of loading. The loading into EEPROM of applications or new APIs for complementing the basic APIs is done by a loader, which can be composed of two parts, a part outside the portable object that can be installed in

the virtual machine outside the portable object (90), called a downloader (93), and a part in the specific platform, called a loader (68).

In a first embodiment, the specific platform (60) comprises two special modules, an API module (65) and a main module (66). The other modules are called service modules (67).

- 5    Each module corresponds to a set of packages that will be stored in the same name space. The API platform designates the basic APIs (62) and all of the system classes that define the API module (65) or the module of the API platform. The main module comprises the main class defining the main program. Each module, except for the API module (65), has one particular class called "Entry Class," which constitutes the point of access to the module. For the main
- 10   module, this "Entry Class" is the main class (CP), the one that contains a static method called "main." For the service modules, it is a class with only one constructor, without parameters and implementing a special public so-called "service" interface defined in the API platform. The loading of an application corresponds to the loading of a service module. Each module receives a specific identifier. Such an identifier, which is called MID, can for example be a number, a character string, or an array. For the sake of example, the identifier is a character
- 15   string.

When they are loaded into the platform by downloading mechanisms distinct from the virtual machine of the specific platform, the modules receive a number between 0 and n.

Thus, based on this convention, n+1 modules at most can be present in the specific platform.

- 20   During the loading of new service modules, the module downloader (93), along with the loader (68), maintains an array (TRM) (69) representing the modules. The number associated with a module is the index (IM) of this module in the array. The loader (68) also maintains a table (70) associating the index (IM) with the identifier (MID) of each module. The API module systematically receives, for the index  $IM_0$ , the number 0, and the main module
- 25   receives for the index  $IM_1$  the number 1. The header of each module includes an indicator that allows the loader to determine the nature of the module – "main," "service," or "API" module.

The loader (68) can only load modules that are authorized to reside in the portable object, i.e., only modules having a signature recognized by the portable object. The loader

- 30   (68) therefore includes means for verifying the signature of a received module, for comparing it to the signature recognized by the portable object, and in case of a negative comparison, for prohibiting the loading.

Conventionally, as defined in the prior art mentioned above, the source program (81) of an application is written, then compiled by a compiler (82), and then verified by the verifier (91).

The static linking, performed in the converter (92) by a component of the converter

5 called a linker, will resolve the symbolic references by assigning

- a number (NCI) to each class of a module,
- a number (NM) for each method in a class, and
- a number (NA) for each attribute in a class.

Each of these numbers (NCI, NM, NA) is between 0 and n, and can thus be

10 represented by a byte. For example, each of these numbers is between 0 and 255 (n=255).

The reference to a method or an attribute of a class will thus be coded into the linked pseudocode of the methods of the module in two bytes. The pseudocode will contain these two bytes, <NCI> for the class, and <NA> for an attribute or <NM> for a method.

According to Fig. 3, the internal representation of an API module (65), a main module (66), or a service module (67) will contain an array (TRC) representing classes; the number (NCI) associated by the linker outside the embedded system with each class is the index (ICi) of the representation of this class in the array (TRC). Each class also has a reference to the index IMi of its module. Likewise, the representation of each class contains an array representing the methods (TRMe) and an array representing the attributes (TRA) belonging to the class. The number (NM) associated by the linker outside the embedded system with each method is the index IMi of the representation of this method in the array (TRMe), and the number (NA) associated by the linker outside the embedded system with each attribute is the index (IAi) of the representation of this attribute in the array (TRA).

For example, we want a module to be able to refer only to its own classes and to the system classes of the API platform, the system classes corresponding to the classes of the “ClassPath” of a conventional platform. According to the invention, in order to make it possible to distinguish between a reference to a class internal to the module and the reference to a system class (or class external to the module), an internal (II) or external (IE) indicator is added to the reference to a method or an attribute. The resolved reference is then coded in three bytes: <IE/II> <NCI> <NM> or <IE/I> <NCI> <NA>

In accordance with an established convention, for the value n of the first byte <IE/II>, the value 255 in our example, corresponds to a reference <II> internal to the module, and any other value for the first byte corresponds to a reference <IE> external to the module.

The linker of the converter (92) of the virtual machine outside the portable object

5 (90), first links the API module (65), which does not have any external references <IE> in its pseudocode , and produces a layout or arrangement corresponding to a scheme of symbolic names of its classes and their methods and attributes. During the linking of the other modules, this layout will be used to establish the external references to system classes of the API module (65).

10 Based on our convention for the bytes encoding the references, there can be at most 256 (n+1) classes in the API module and 256 classes in each additional module.

During the execution of a service module, when the virtual machine (61) finds a reference to a method <NM> or an attribute <NA> in the pseudocode, knowing the class <NCI> in which this reference is found, it can directly retrieve the index <IMi> of the module in question, the latter corresponding to the external (IE) or internal (II) reference. Any external reference <IE> in the pseudocode of a service module will be systematically interpreted by the virtual machine as a reference to the API module. A service module or the main module cannot refer to the classes of any other module except those of the API module. The system classes of this API module cannot refer to the classes of a service module or the main module. The internal reference to a class of a module, corresponding to the value n for the first byte, does not require any knowledge *a priori* of the name space that will be assigned to the module. The fact that no fixed name space is defined *a priori* during the conversion phase makes it possible to accelerate the resolution of the references and to determine the naming space of a module during the loading, after the conversion phase. The virtual

15 machine, during the interpretation of a reference to an attribute or a method in the pseudocode, uses the three cascaded indexes <IE/II> <NCI> <NM> or <IE/II> <NCI> <NA>. The memory space of the module being determined, the index <NCI> determines the desired entry into the array (TRM) of the classes of the module, then the last index <NM> or <NA> gives the desired entry into the method array (TRMe) or the attribute array (TRA).

20

25

30 The API module comprises a special class (64), called class “Access Manager”, which comprises a native method (getServiceInstance) whose role is to return an object that is an instance of the input class of the requested service module, from the identifier (MID) of the

module. This method uses the MID/IMi association table (70) to find the index of the requested module in the module array (69), then creates an instance of the input class of this module, an instance that is returned by the method. According to the invention, the class “Access Manager” (64) is protected by construction by a method that consists of prohibiting this class from having more than one instance. This method (getServiceInstance) belongs to the main program contained in the main module. The main module, which is activated first when the portable object is used, creates one and only one instance of the class “Access Manager”, which allows it to use the method getServiceInstance, but bars any other service from creating another instance for using this method.

In operation, just like in a conventional platform, the runtime environment (RE) accesses the input class (EC) of the main module and activates its input method (main). The main module, being the first one activated, installs an instance of the class “Access Manager” before any other service does so, since in order to activate other services, the main module must already have such an instance of the access class.

This simple device makes it possible to reproduce the protective effect linked to the concept of a naming space in a conventional platform. The simple fact that a service module is loaded into the module array, and that the presence in the pseudocode of any external references is interpreted by the virtual machine as a reference to the API module, renders this module completely inaccessible directly by the other modules, thus creating a total firewall.

This first embodiment makes it possible to obtain the advantages of a firewall produced by name space separation in the context of a two-part virtual machine. However, this embodiment is not very flexible, and has two drawbacks.

First, it prevents any modification or extension of the system classes with modules that are already pre-linked. A conventional Java architecture makes it possible to modify and extend the classes of the API platform without having an impact on the already compiled classes of additional modules. But in the embodiment described above, any modification of the system classes, although invisible for alien modules, would modify the layout of the API platform and would make it necessary to modify the pre-linked pseudocode of each module already linked with a prior version of the layout, and consequently the interpreter.

Secondly, the pre-linked modules are assumed to be portable between the various embedded platforms or terminals, which requires each of these platforms to have the same layout as the API platform, thus prohibiting the utilization of any proprietary extension.

In order to partially remedy these drawbacks, a variant of the first embodiment consists of requiring that, in the numbering of the layout, the public classes come first, before the classes in private packets. In addition, the public methods or public attributes come before those that are protected and those that are in private packages and in private classes. This  
5 makes it possible to freely add new public classes into the API module (API).

Fig. 2 represents a second embodiment that allows upgrading of the API platform. The API platform is constituted by several API modules (100) that can be loaded separately, instead of being constituted by a single API module.

In this embodiment, the downloader (93) and the virtual machine share two module  
10 arrays and two MID/index association tables instead of one of each, an array (101) and an association table (102) for the API modules and an array (103) and an association table (104) for the non-API modules corresponding to the service module (67) and the main module (66).

Each module has in its header an indicator indicating its nature, “Service” or “API”, which allows the loader to load the module into the API module array (101) or into the non-  
15 API module array (103). This indicator is placed in the header of the module during the compilation phase by the converter.

The firewall constituted by the separation of the name space is present only between the non-API modules. Any external reference to a service module will be interpreted by the interpreter of the on-platform virtual machine as an index of the API module array.

The non-API modules are numbered from 0 to 255 at most, in the example in which  
20 n=255. For example, 0 is the index of the main module (66). The API modules (100) are numbered from 0 to 254 at most, 0 being for example the index of a so-called primary API module, which contains all of the native methods. According to the convention described above, this allows at most 255 (n) different modules in the API platform. The reference to a  
25 method or attribute in the pseudocode is:

<<IE/II> <NCI> <NM/NA>>

The value 255 (n) for the first byte indicates, as in the first embodiment, a reference internal to the module. Each value different from 255 indicates a reference external to a specific module (100) of the API module array of the API platform.

After the performance of the linking by the off-platform linker (92), the pseudocode  
30 of a module includes a header having an array of referenced modules used to link the current module. This referenced module array comprises at most 255 entries, each entry

corresponding to the identifier (MID) of an API module (100). The first byte of an external reference in the pseudocode will therefore be an index in this array. When a non-API module (67, 66) is loaded into the platform, the index numbers associated with API modules (100) are known, and thus each first byte of an external reference is replaced by the index number  
5 associated with the referenced API module using the MID/IMi association table (102) of the API modules (100). This replacement is the only linking operation performed in the specific platform by the loader (68), the MID/IMi association table (102) being used only for performing this linking operation.

For the sake of example, let's assume that in the pseudocode of a service module

10 "TEST", we have the reference to a method number 5 of class number 7 of an API module whose identifier (MID) is "F00". Let's also assume that "F00" is the identifier of the fourth external API module found referenced in the service module "TEST". The reference in the pseudocode is therefore constituted by the following three values: 3, 7, 5.

The number 3 corresponds to the fourth index in the array of referenced modules  
15 present in the header of the module, which comes at the beginning of the pseudocode, the value of this entry being the identifier (MID) "F00". Let's assume that at the time the API module "F00" is loaded, the internal index 34 has been assigned to it in the target platform, in the association table (102) of the API modules. Therefore, the loader (68), using the  
20 association table (102), modifies the reference in the pseudocode of the service module "TEST" so that it becomes: 34, 7, 5.

During the execution of the pseudocode of a module, a reference external to the module is systematically interpreted by the virtual machine as an entry in the API module array. The modules of the non-API module array remain invisible to one another as well as to the other API modules. This simple device makes it possible to reproduce the protective  
25 effect linked to the concept of a naming space in a conventional platform. The simple fact that a module is loaded into the non-API module array makes it completely inaccessible directly by the other modules, thus creating a total firewall.

The API module array (101) comprises a specific module (105), called an "API Access" module, which comprises a native method (getServiceInstance) in a class "Access  
30 Manager" whose role is to return an object that is an instance of the input class of the requested service module. This method uses the MID/IMi association table (104) to find the index of the requested service module in the non-API module array (103), then creates an

instance of the input class of this module, which is returned by the method to the main program. The recommended security policy is to make the class “Access Manager” a protected class whose constructor and methods are declared protected. In addition, the “API Access” module (105) includes a protection consisting of prohibiting the class “Access

5 Manager” from having more than one instance. This method is reserved for the main program contained in the main module (66). The main module, which is activated first, creates an instance of the module Access Manager, which allows it to use the method getServiceInstance, but prohibits any other service from creating another instance for using this method. Thus, the main module can create service instances.

10 Several methods can be used to obtain this protection, which consists of prohibiting the class “Access Manager” from having more than one instance. The constructor of the class “Access Manager” can, for example, inhibit the request for creating an instance when one already exists and trigger a security exception. In operation, the runtime environment (RE) accesses the input class of the main module (66) and activates its input method (main). The main module, being the first one activated, installs an instance of the class “Access Manager” of the Access module before any other service does so.

15 In order to allow a service module to activate another service module, this strict security policy can be modified by adding to the class “Access Manager” of the API Access module (105) public classes that will allow any module to send requests to it. These requests will be processed and controlled by the sole instance created by the main module. These 20 public classes specifically include a static method that makes it possible to obtain the sole instance. A module having access to the object that is the instance of the class “Access Manager” can activate another service module and use it, but it cannot directly reference its classes, its methods or its attributes without being referred by the virtual machine, given that 25 any external reference in the pseudocode is a reference internal to the module or a reference external to an API module.

For a simple embodiment of this solution, it is necessary not to have circular references among the API modules. Consequently, the transitive closure of the relation “refers to” must be a strict partial order on a set of modules. It is thus possible to design, in 30 the linker of the converter (92), a simple strategy for linking and producing the layout of the API modules by first processing the minimum elements not yet linked. It is possible to use the same strategy based on a partial order for downloading the API modules, so that when a

module M is downloaded, all of the modules to which it refers have already been downloaded, and a number has been assigned to them. The assignment of the internal index in the target platform is done by the module loader (68) by assigning the index n-1 to the API of order n. An API module cannot refer to another API module with a higher index.

5       The utilization of this system of dual module arrays (101, 103) and association tables (102, 104) makes it easy to replace a single API module with several API modules that can be loaded separately. The replacement of a single API module with several API modules makes it possible to extend the API platform with new modules, without modifying the linking of the modules already loaded, and without changing the security provided by the firewalls. Of  
10 course, these two embodiments are not compatible; the modules must be pre-linked specifically for one embodiment or the other, the pseudocode related to one of the embodiments not being portable to a platform implementing the other embodiment.  
Moreover, the interpreter of the virtual machine differs from one embodiment to the other. In  
15 the first embodiment, the virtual machine manipulates only one array and one association table; the first byte of a reference is interpreted by the virtual machine as an internal reference for any value equal to n, and as an external reference to the sole API module for any value different from n. In the second embodiment, the virtual machine manipulates two arrays and two association tables: the first byte of a reference in the pseudocode is interpreted by the virtual machine as a reference internal to the module for any value equal to n, and any value different from n will be taken directly as an index in the API module array. In both  
20 embodiments, the interpreter of the virtual machine comprises means for comparing the first byte of the three coding bytes of a reference to a method or an attribute with a given value n in order to decide whether it refers to a class that is internal or external to the module. The numbering of the API modules can be determined at the time of loading, in order to  
25 permanently set the external references in the pseudocode in a very simple way.

The same mechanisms are used to handle both types of modules, although the way in which they are used and the security obtained are entirely different. Any module can freely access the API modules, since their classes are system classes. The utilization of the modular approach is used with the service modules to obtain a strong firewall for protecting these  
30 modules from any direct access.

The method according to the invention can be implemented in any type of portable object having limited resources, such as for example 16 Kb of ROM, 8 Kb of EEPROM and 256 k of RAM.

Other modifications within the capability of one skilled in the art are also part of the  
5 spirit of the invention.

## CLAIMS

1           1. Method for loading applications into an embedded system comprising a  
2 runtime environment including a virtual machine comprising an intermediate pseudocode  
3 language interpreter and application programming interfaces (API), from a station on which  
4 the source code of the application is written, compiled into pseudocode by a compiler (82),  
5 verified by a verifier (91), converted by a converter (92) and loaded by a loader (93, 68), is  
6 characterized in that:

7           - the conversion comprises the performance of the static linking of a plurality of sets  
8 of packages to be stored in the same name space in the embedded system, called modules, by  
9 assigning an identifier to each module (MID), and a reference number to each class (NCI),  
10 each method (NM) and each attribute (NA) encapsulated in the classes of the module,

11           - the reference to a method or an attribute in the linked pseudocode of a module,,  
12 being coded in three bytes constituted by an indicator indicating the reference to a class  
13 internal (II) or external (IE) to the module, the number of the class (NCI), and either the  
14 number of the method (NM) or the number of the attribute (NA),

15           - the modules loaded are one or more application program interface modules  
16 comprising system classes or service modules, each corresponding to an application, a  
17 reference (IE) to an external class being systematically interpreted by the virtual machine as a  
18 reference to an application program interface module.

1           2. Method for loading applications into an embedded system according to claim  
2 1, characterized in that the loading of the modules into the embedded system comprises the  
3 storage of at least one array (69, 101, 103) representing the modules, the number (IMi)  
4 between 0 and n associated by the linker with a module constituting the index of said module  
5 in the array, and a table (70, 102, 104) storing the association of the index in the array  
6 representing the identifier (MID) of said module, said array and the table being in  
7 programmable nonvolatile memory, an external reference (IE) to an external module in the  
8 pseudocode being interpreted by the interpreter of the virtual machine as constituting an  
9 index for access to the module equivalent to the one in the module array.

1           3.     Method for loading applications into an embedded system according to claim  
2     2, characterized in that the loading comprises the storage, for each module, of an array (TRC)  
3     representing its classes, comprising a reference to the index of its module and, for each class,  
4     an array representing attributes (TRA) and methods (TRMe).

1           4.     Method for loading applications into an embedded system according to claim  
2     2, characterized in that the modules are referenced in a single module array, the system  
3     classes are different from n will be interpreted by the virtual machine as a reference to said  
4     API module.

1           5.     Method for loading applications into an embedded system according to claim  
2     4, characterized in that the classes being declared public, or in private packages, the  
3     attributes and methods being declared protected, in private packages or in private classes, the  
4     numbering of the classes is done in order of the public classes followed by the classes in  
5     private packages; the numbering of the attributes or methods is done by the converter (92) in  
6     order of the attributes or methods that are public, protected in private packages, and in private  
7     classes.

1           6.     Method for loading applications into an embedded system according to claim  
2     2, characterized in that the system classes are contained in several API modules that can be  
3     loaded separately, the loader (68) maintains in the programmable nonvolatile memory two  
4     arrays representing modules and two corresponding MID/IMi association tables, one for the  
5     API modules and the other for the non-API modules, the loader loading the modules into one  
6     of the two arrays based on the nature of the module specified in its header, any external  
7     reference of a module of the module array being interpreted as a reference to the index of the  
8     API module.

1           7.     Method for loading applications into an embedded system according to claim  
2     6, characterized in that static linking of a module is performed in such a way that the  
3     reference to a class external to a non-API module in the intermediate pseudocode is an index  
4     in an array of the header of the module, wherein each entry is an identifier (MID) of a  
5     referenced API module, the loading of said module into the target platform comprising the

6 replacement of said reference with the number of the index of the API module obtained from  
7 the identifier (MID) in the MID/IMi association tables of the API modules.

1       8.     Embedded system comprising a virtual machine and an API platform  
2 including application program interfaces, a fixed nonvolatile memory, a programmable or  
3 modifiable nonvolatile memory, and a random access memory, is characterized in that the  
4 programmable nonvolatile memory comprises at least one API module comprising system  
5 classes and service modules, at least one array representing modules (TRM), in which the  
6 modules are indexed, and a table (70, 104) associating the index (IM) of a module in the  
7 representing array with the identifier (MID) of said module, each module comprising an array  
8 for representing classes (TRC), in which the classes are indexed and in which each class has a  
9 reference to the index (IM) of its module, each class comprising an array for representing  
10 attributes (TRA) and methods (TRMe), in which the attributes and methods are indexed, the  
11 reference to a method or an attribute being coded in at least three bytes corresponding to a  
12 reference to a class internal (II) or external (IE) to the module, a reference external to the  
13 module constituting the index of the API module in the module array, a class number (NCI)  
14 corresponding to the index of the class in the table representing the classes of the module, and  
15 a method (NM) or attribute (NA) number corresponding to the index or the method or the  
16 attribute in the array representing the methods or attributes of the class of the module.

1       9.     Embedded system according to claim 8, characterized in that it includes means  
2 for comparing the first byte of the three bytes encoding a reference to a method or an attribute  
3 to a given value n in order to decide whether it is an internal or an external class.

1       10.    Embedded system according to claim 8, characterized in that it comprises a  
2 main module comprising the main program of the system.

1       11.    Embedded system according to claim 8, characterized in that the classes are  
2 indexed in order of the public classes followed by the classes in private packages, and the  
3 attributes and methods are indexed in the order of the attributes or methods that are public,  
4 protected, in private packages, and in private classes.

1           12. Embedded system according to claim 11, characterized in that the  
2 programmable nonvolatile memory comprises several API modules comprising system  
3 classes, two arrays (101, 103) representing modules, one for the API modules and the other  
4 for the non-API modules and the main module, and two MID/IMi association tables (102,  
5 104), each corresponding to an array representing modules.

1           13. Embedded system according to claim 10, characterized in that it comprises an  
2 access manager class “Access Manager” of an API module (105) comprising a method that  
3 makes it possible to create an instance of a service module, via the main module, said class  
4 having a protection that prohibits it from having more than one instance.

1           14. Method for executing an application of a multi-application embedded system,  
2 comprising a runtime environment including a virtual machine comprising an intermediate  
3 pseudocode language interpreter and application programming interfaces (API), is  
4 characterized in that during the execution of the intermediate pseudocode of a service  
5 module, corresponding to an application, referenced in a module array, the reference to a  
6 method or an attribute in the pseudocode, coded in at least three bytes corresponding to a  
7 reference to a class internal (II) or external (IE) to the module, a class number (NCI) and a  
8 method (NM) or attribute (NA) number, a reference external to the module is interpreted by  
9 the virtual machine as a reference to the index of an API module in the array of the API  
10 module or modules.

1           15. Method for executing an application of a multi-application embedded system  
2 according to claim 14, characterized in that, upon reception of a request for execution of a  
3 service module having an identifier (MID), the runtime environment accesses the input class  
4 of a main module comprising the main program of the system, the main module installs an  
5 instance of a special class “Access Manager” of an API module that controls access to a  
6 service module and uses a method of this class for creating an instance of the input class of  
7 the requested service module, by means of a table associating the identifier with the index of  
8 the module in an array in which the module is referenced, the instance being returned by the  
9 method to the main program.

## **ABSTRACT**

**METHOD FOR LOADING APPLICATIONS IN A MULTIAPPLICATION  
5 ONPLATFORM SYSTEM EQUIPPED WITH DATA PROCESSING RESOURCES,  
CORRESPONDING EXECUTING SYSTEM AND METHOD**

The present invention relates to a method for loading applications into a multi-application embedded system, the corresponding embedded system, and the method for executing an application of the embedded system. The method for loading applications into an embedded system comprising a runtime environment including a virtual machine comprising an intermediate pseudocode language interpreter and application programming interfaces (API), from a station on which the source code of the application is written, compiled into pseudocode, verified and converted, is characterized in that the conversion comprises the performance of the static linking of a plurality of sets of packages to be stored in the same name space in the embedded system, called modules, and constituting an application program interface module or a service module corresponding to an application, and consists of assigning an identifier to each module (MID) and a reference number to each class (NCI), each method (NM) and each attribute (NA). The reference to a method or an attribute in the linked pseudocode of a module is coded in three bytes constituted by an indicator indicating the reference to a class internal (II) or external (IE) to the module, the number of the class (NCI), and either the number of the method (NM) or the number of the attribute (NA), a reference (IE) to an external class being systematically interpreted by the virtual machine as a reference to an application program interface module.

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**IN THE UNITED STATES DESIGNATED/ELECTED OFFICE  
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For: Method for Loading Applications in a Multiapplication Onplatform System Equipped with Data Processing Resources, Corresponding Executing System and Method

McLean, Virginia  
July 17, 2001

**PROPOSED DRAWING CORRECTIONS**

Honorable Commissioner of Patents  
Washington, D.C. 20231

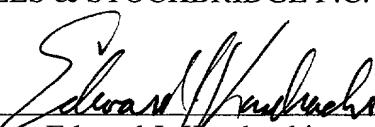
Sir:

Applicant requests approval of the drawing corrections on Figs. 1 – 4c as shown in red on the attached four (4) sheets.

The proposed corrections only comprise translating the French term into English and removing the headings “PL 1/4 – PL 4/4” to conform the drawings to U.S. practice.

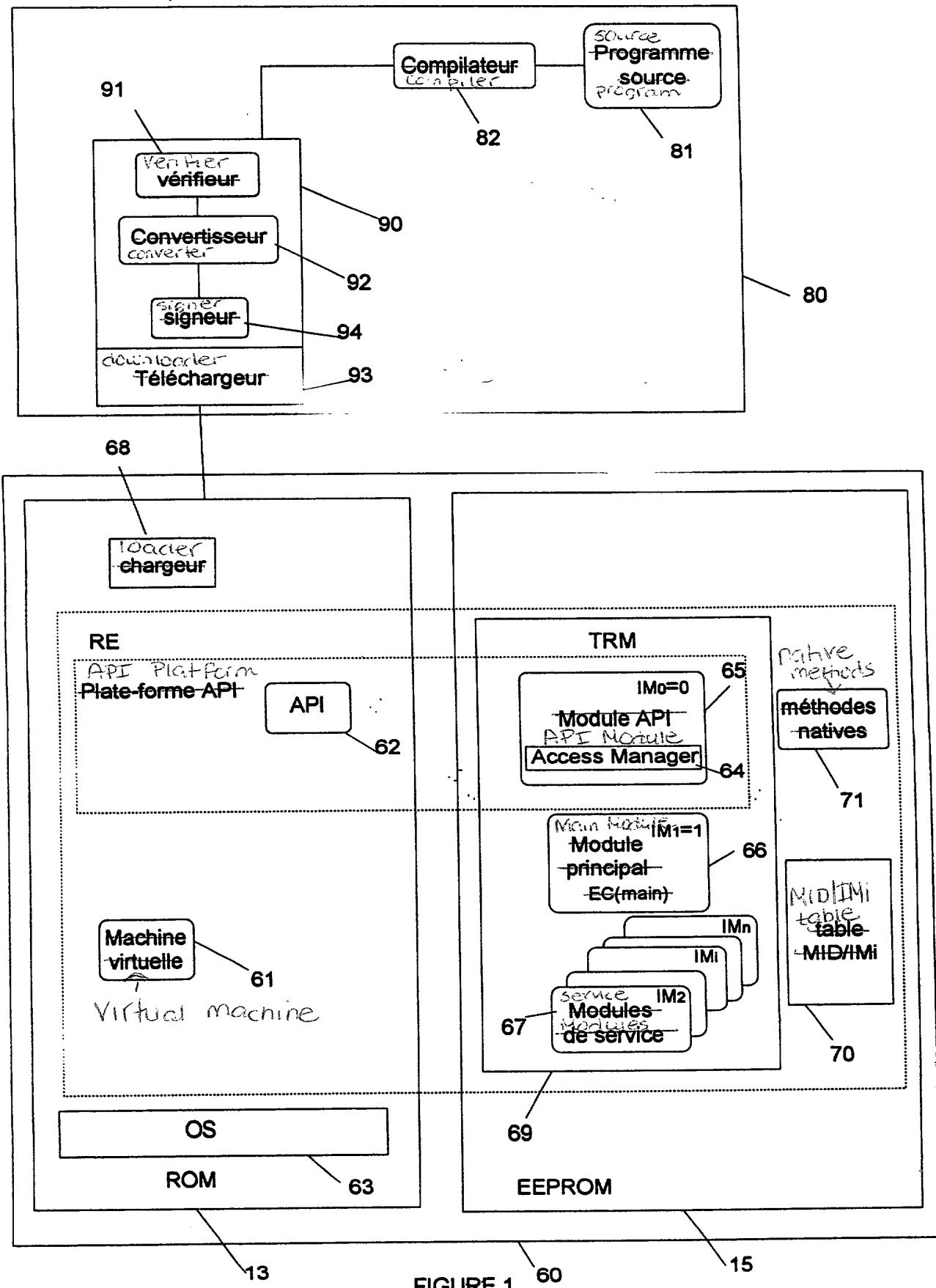
Respectfully submitted,

MILES & STOCKBRIDGE P.C.

By:   
Edward J. Kondracki  
Reg. No. 20,604

1751 Pinnacle Drive, Suite 500  
McLean, Virginia 22102-3833  
Telephone: (703) 903-9000  
#9150632v1

PL 1/4



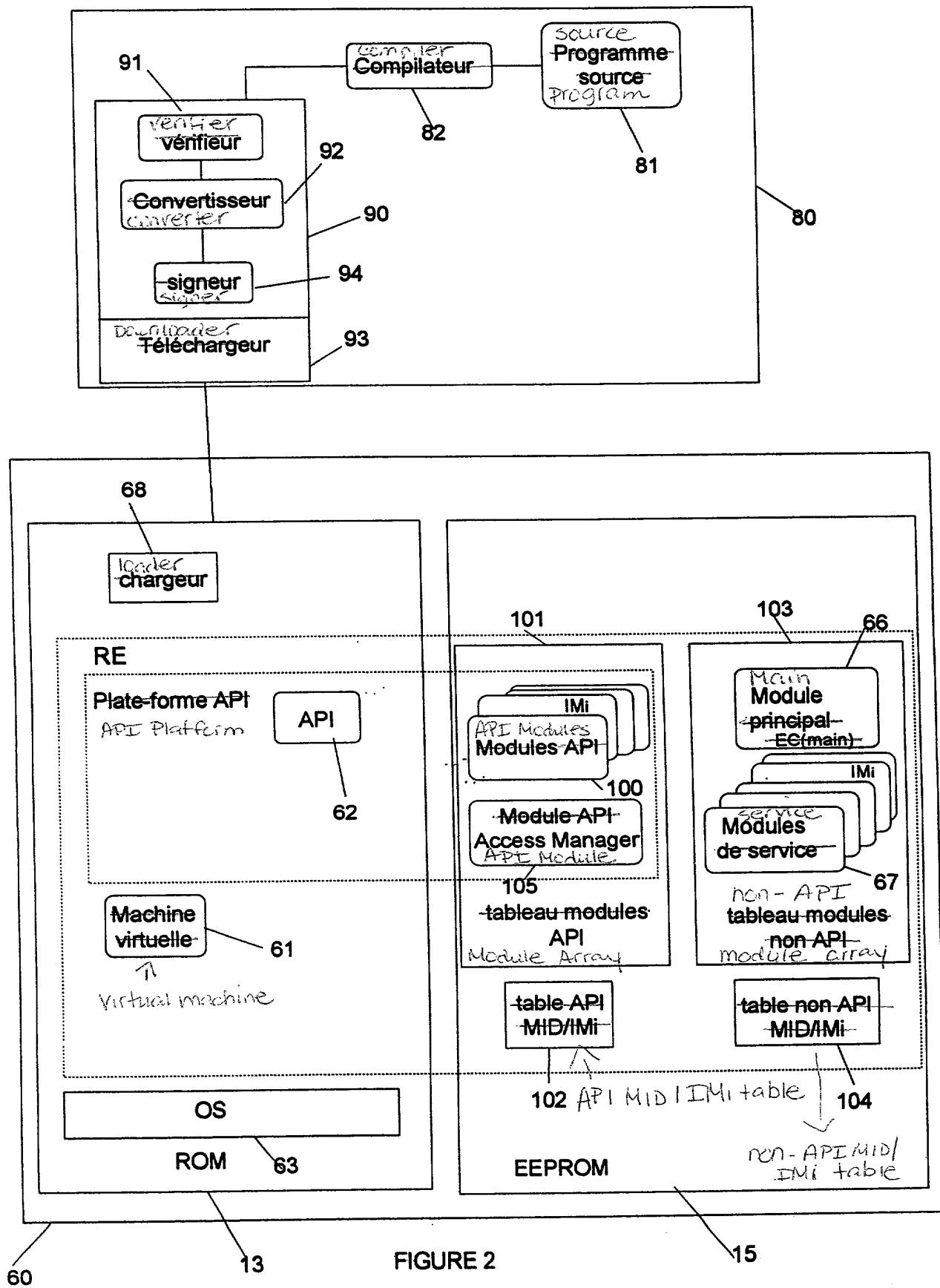
~~PL 2/4~~

FIGURE 2

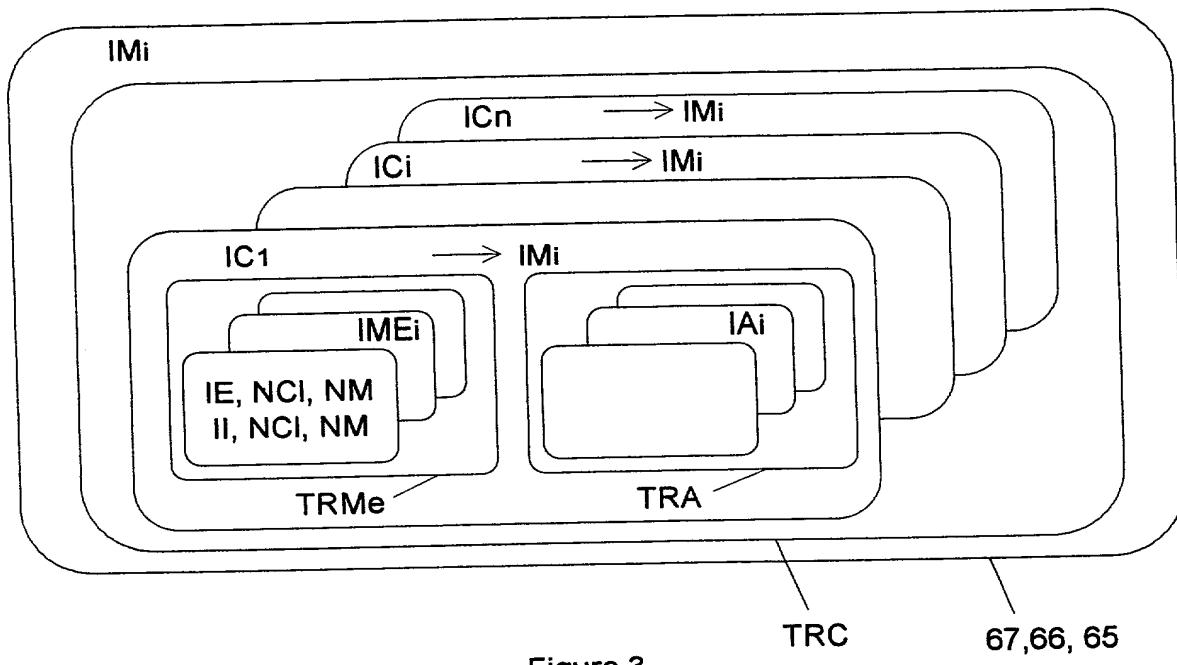
~~PL 3/4~~

Figure 3

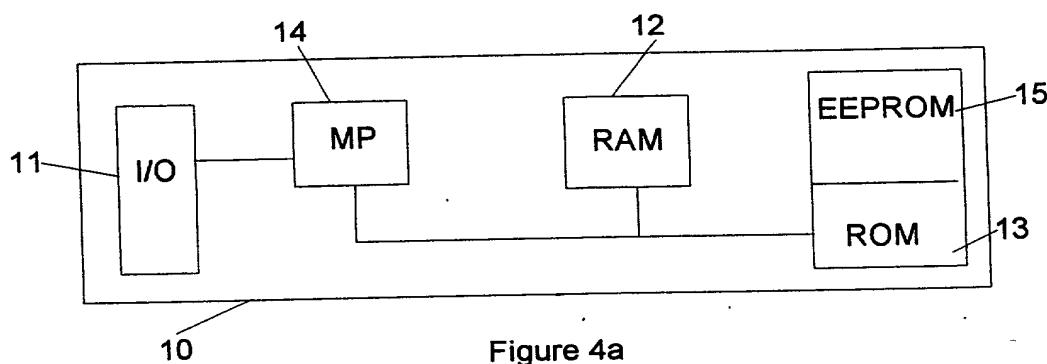


Figure 4a

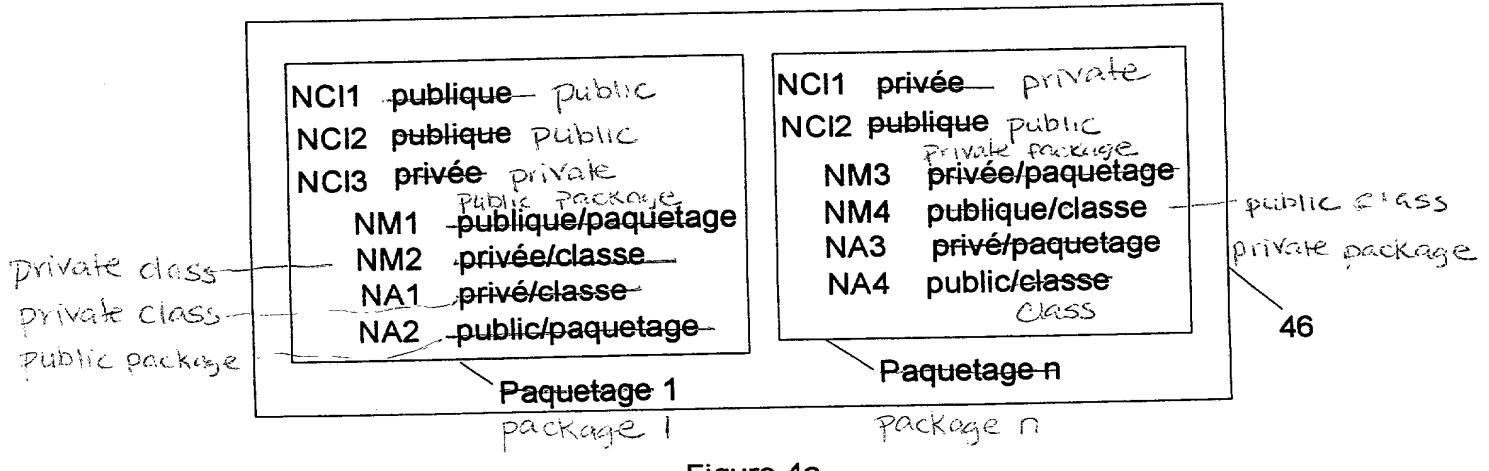


Figure 4c

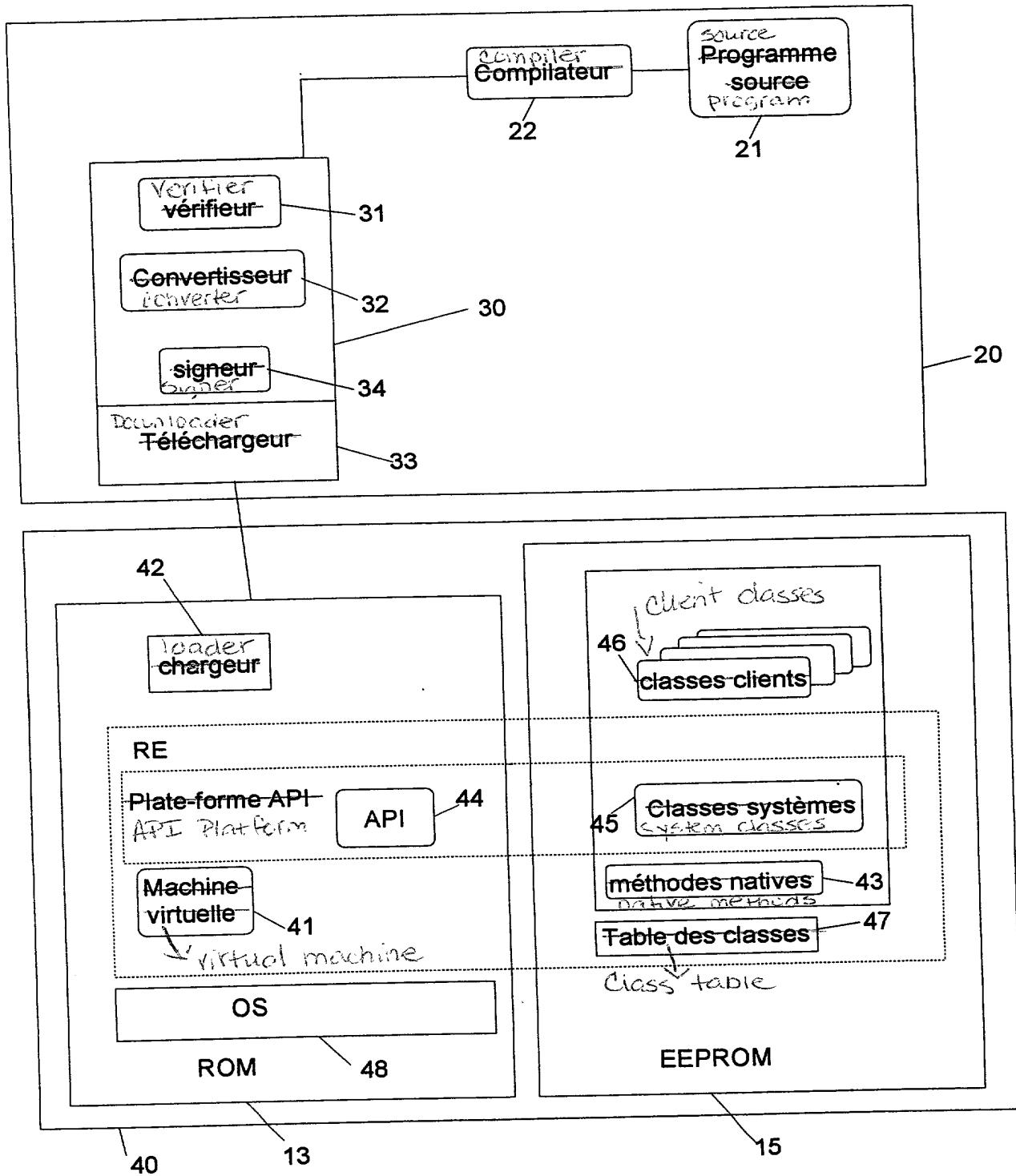
~~PL 4/4~~

FIGURE 4b

# Declaration and Power of Attorney for Patent Application

## Déclaration et Pouvoirs pour Demande de Brevet

### French Language Declaration

En tant que l'inventeur nommé ci-après, je déclare par le présent acte que:

Mon domicile, mon adresse postale et ma nationalité sont ceux figurant ci-dessous à côté de mon nom.

Je crois être le premier inventeur original et unique (si un seul nom est mentionné ci-dessous), ou l'un des premiers co-inventeurs originaux (si plusieurs noms sont mentionnés ci-dessous) de l'objet revendiqué, pour lequel une demande de brevet a été déposée concernant l'invention intitulée:  
**Procédé de chargement d'applications dans un système embarqué multi-application muni de ressources de traitement de données, système embarqué correspondant, et procédé d'exécution d'une application d'un système embarqué correspondant.**

et dont la description est fournie ci-joint à moins que la case suivante n'ait été cochée:

- a été déposée le \_\_\_\_\_  
 sous le numéro de demande des Etats-Unis ou le numéro de demande international PCT \_\_\_\_\_ et modifiée le \_\_\_\_\_ (le cas échéant).

Je déclare par le présent acte avoir passé en revue et compris le contenu de la description ci-dessus, revendications comprises, telles que modifiées par toute modification dont il aura été fait référence ci-dessus.

Je reconnaiss devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code fédéral des réglementations.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

\_\_\_\_\_  
 \_\_\_\_\_

the specification of which is attached hereto unless the following box is checked:

- was filed on \_\_\_\_\_  
 as United States Application Number or PCT International Application Number \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

**French Language Declaration**

Je revendique par le présent acte avoir la priorité étrangère, en vertu du Titre 35, § 119(a)-(d) ou § 365(b) du Code des Etats-Unis, sur toute demande étrangère de brevet ou certificat d'inventeur ou, en vertu du Titre 35, § 365(a) du même Code, sur toute demande internationale PCT désignant au moins un pays autre que les Etats-Unis et figurant ci-dessous et, en cochant la case, j'ai aussi indiqué ci-dessous toute demande étrangère de brevet, tout certificat d'inventeur ou toute demande internationale PCT ayant une date de dépôt précédant celle de la demande à propos de laquelle une priorité est revendiquée.

## Prior foreign application(s)

Demande(s) de brevet antérieure(s)

**9914454****FR**

(Number) (Numéro)	(Country) (Pays)
----------------------	---------------------

(Number) (Numéro)	(Country) (Pays)
----------------------	---------------------

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35, § 119(e) du Code des Etats-Unis, de toute demande de brevet provisoire effectuée aux Etats-Unis et figurant ci-dessous.

(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)
--------------------------------------	----------------------------------

(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)
--------------------------------------	----------------------------------

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35, § 120 du Code des Etats-Unis, de toute demande de brevet effectuée aux Etats-Unis, ou en vertu du Titre 35, § 365(c) du même Code, de toute demande internationale PCT désignant les Etats-Unis et figurant ci-dessous et, dans la mesure où l'objet de chacune des revendications de cette demande de brevet n'est pas divulgué dans la demande antérieure américaine ou internationale PCT, en vertu des dispositions du premier paragraphe du Titre 35, § 112 du Code des Etats-Unis, je reconnaiss devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code fédéral des réglementations, dont j'ai pu disposer entre la date de dépôt de la demande antérieure et la date de dépôt de la demande nationale ou internationale PCT de la présente demande:

**PCT/FR00/03193****17/11/00**

(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)
--------------------------------------	----------------------------------

(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)
--------------------------------------	----------------------------------

Je déclare par le présent acte que toute déclaration ci-incluse est, à ma connaissance, vérifique et que toute déclaration formulée à partir de renseignements ou de suppositions est tenue pour vérifiable; et de plus, que toutes ces déclarations ont été formulées en sachant que toute fausse déclaration volontaire ou son équivalent est passible d'une amende ou d'une incarcération, ou des deux, en vertu de la Section 1001 du Titre 18 du Code des Etats-Unis, et que de telles déclarations volontairement fausses risquent de compromettre la validité de la demande de brevet ou du brevet délivré à partir de celle-ci.

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Claimed  
Droit de priorité revendiqué

**17/11/99**(Day/Month/Year Filed)  
(Jour/Mois/Année de dépôt)(Day/Month/Year Filed)  
(Jour/Mois/Année de dépôt)

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

**PENDING**

(Status) (patented, pending, abandoned)  
(Statut) (breveté, en cours d'examen, abandonné)

(Status) (patented, pending, abandoned)  
(Statut) (breveté, en cours d'examen, abandonné)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## French Language Declaration

**POUVOIRS:** En tant que l'inventeur cité, je désigne par la présente l'(les) avocat(s) et/ou agent(s) suivant(s) pour qu'ils poursuive(nt) la procédure de cette demande de brevet et traite(nt) toute affaire s'y rapportant avec l'Office des brevets et des marques: (mentionner le nom et le numéro d'enregistrement).

Adresser toute correspondance à:

Adresser tout appel téléphonique à:  
(nom et numéro de téléphone)

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

Edward J. Kondracki, Reg. No. 20,604Dennis P. Clarke, Reg. No. 22,549William L. Feeney, Reg. No. 29,918John C. Kerins, Reg. No. 32,421

Send Correspondence to:

Miles &amp; Stockbridge P.C.

1751 Pinnacle Drive, Suite 500

McLean VA 22102-3833

Direct Telephone Calls to:

(name and telephone number)

703-903-9000

Nom complet de l'unique ou premier inventeur <b>GOIRE Christian</b>	Full name of sole or first inventor	
Signature de l'inventeur <b>CRX</b>	Date <b>12/11/2000</b>	Inventor's signature Date
Domicile <b>8 allée du Mail 78340 LES CLAYES SOUS BOIS - FRANCE</b>	Residence	
Nationalité <b>Française</b>	Citizenship	
Adresse postale <b>8 allée du Mail 78340 LES CLAYES SOUS BOIS - FRANCE</b>	Post Office Address	
Nom complet du second co-inventeur, le cas échéant <b>BILLON Jean Paul</b>		
Signature du second inventeur <b>MH</b>	Date <b>12/11/00</b>	Second Inventor's signature <b>MH</b> Date <b>12/11/00</b>
Domicile <b>96 Uranus terrace CA 94114 SAN FRANCISCO - ETATS-UNIS</b>	Residence	
Nationalité <b>Française</b>	Citizenship	
Adresse postal <b>96 Uranus terrace CA 94114 SAN FRANCISCO - ETATS-UNIS</b>	Post Office Address	

(Fournir les mêmes renseignements et la signature de tout co-inventeur supplémentaire.)

(Supply similar information and signature for third and subsequent joint inventors.)